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Need of Unity.

There has been lately a good deal of aspiration and effort to give the profession of architecture its proper place in the American community,—or perhaps it is better to say, its deserved consideration, since its proper place can hardly, as yet, be accounted fixed. The body of architects have gained greatly in influence and respect during the last score of years or so. And the first reason why they have gained is that they have become a body; that is to say, they are now a class of men, fulfilling a special function in a somewhat uniform way, and with more or less of common understanding among them. Fifty years ago there was no such class here. The men who designed buildings were, ordinarily, the men who built them; and it was only in rare cases, and for structures of unusual importance, that the two or three men in the country who made a profession of designing were called upon. The position of these men was anomalous and individual: most people had nothing to do about it, knew and thought nothing about it. As towns grow, and building increased, architects became more common; but their position and influence were for a long time determined in each case only by the success and action of the individual. It was but slowly that they were accepted as a class, or that any defined usages grew up in their relations to the public or their clients.

Even now those relations and usages are far from being universally determined and recognized. Not only are architects not yet accepted as the authoritative arbiters in all matters of design that many of them think they should be; but, among people at large, their authority, responsibility, compensation, and especially the manner of dealing with them, are by no means uniformly established. But if we consider also, how far architects are from having an accepted standard either of taste, style, or practice, among themselves, and with how slender a stock of acquirement many of them set to work, we shall perhaps conclude that as much confidence is given them as they have, on the whole, shown themselves entitled to. It should be remembered that respect is not a gift, but a tribute; and the individual or the body who would acquire it in a community as independent as ours must compel it. Particular architects have won it by force of talent or business capacity; but the success of the profession, as a whole, will be unsatisfactory so long as its standard of performance is uncertain. Something may be accomplished—a good deal has been accomplished, in a business way—by the general consent of architects, as well as by the direct efforts of the American Institute, in fixing a regular scale of charges, and certain general rules of conduct. A closer defensive alliance would, of course, have its effect upon clients, and in some respect is desirable. But so long as practice and taste vary among us as they do, an architect's action will carry only the weight due to his own personal repute: the fact that it is professional will add little to it. In matters of design especially, in which the profession would like to establish its supremacy, when also the business client is expected to show most deference, if he finds doctors divided among themselves, he will either run after the fashionable man of the hour, or else, being naturally self-reliant, will think that in the conflict of authority his own judgment is as safe a guide as any. In neither case is he likely to recognize the existence of any more absolute standard than the fancy which he chooses to follow.

The business difficulties which beset the practice of architecture are troublesome, and are increased by the want of perfectly definite usage in respect of duties and responsibilities; but they will be more easily disposed of than the æsthetic ones. The experience of business men, helped by the common effort of practitioners, may be trusted to settle them in due time. The important function of architects here and now is the lead in the developement and shaping of the most pervasive, the most permanent, the most costly, and practically the most important of arts. The demand for it among us is enormous, and apparently will continue indefinitely. The public interest in it has already become keen. But in design the ways of the profession are far more discordant than in their business practice. One architect adheres more or less closely to one style, another to a different one; others shift constantly from one style to another; more still design without special regard to any style. We are far out of the track in which our grandfathers went contentedly and not unsuccessfully; nor have we yet agreed to walk in any other. As we look forward, the prospect doubtless is full of hope. There has been in the last few years a great gain in professional acquirement among architects. Not only are there many more well-trained men in the ranks, but the standard of performance of the average practitioner has risen greatly. Examples and the means of study have multiplied astonishingly. Architects have grown inventive and enterprising, instead of plodding on in the old paths. But these advantages have brought their attendant difficulties. Enterprise tends to outrun discipline. We are overwhelmed with the abundance of precedent at our hands, and help ourselves with eagerness from all sides, grasping at the new forms, and pressing them into service. For the present this condition is inevitable: we must be content to accept and acknowledge it. The architectural aspect of the country as a whole is, and is likely to be for a long time, simply confusion. There seems to be no short way to unity. There is no city like London or Paris, where a man or men of commanding genius, if such should arise, could secure a sufficient following to compel a movement in a definite direction. There is no distinct tendancy to the general pursuit of any of the styles we draw from; and it is a labor for generations to work the elements of them all into an harmonious whole.

Apart from their business relations, architects are called upon to do two things for their clients. First, they have to invent certain suitable dispositions for dwellings business houses, public buildings, churches,—dispositions, to meet the wants of a community whose growing habits are fast taking shape. There is no danger that this will not be done satisfactorily, for it must be. The clients are men whose eyes are quick for whatever practical convenience and comfort require. As fast as the habits of domestic business and public life become defined, their requirements will become explicit and compulsory; and our architects have a ready inventiveness to meet any want which is clearly seen. Second, they have to develope suitable architectural and decorative forms for their structures, and more or less for all fittings of them. In this it belongs to them to lead the way; to find it, in fact. Now, the constant change from one style to another confuses judgment; and men are busy with comparisons of this or that kind of detail, when they should be thinking of the underlying principles of design on which all good work must rest. Observers are influenced in their approval by their preference for one or another decorative form, instead of considering the essential character of the designs to which they are applied.

The confusion of the public taste is typified in the aspect of our cities. Modern London, we believe, offers the only paralled to the tumultuous incoherence of the architecture of American towns. Not only is there danger that purity of taste and the sense of unity in design will be smothered in this confusion, but it seems as if men would lose the belief that there is good taste and bad taste, and fairly agree that one thing is as good as another. It is a standing reproach to Americans, that they ignore the value of training (except each one in his own business); and in nothing is the reproach more just than in matters of art. Our profession cannot, to be sure, assume a mission to meet all this single-handed. We cannot arrogate to ourselves the lofty function of dictating the public taste; but it is laid on us to execute works that must influence it as much as the others, and perhaps more permanently. Yet not only is it impossible that our cities and our streets shall produce, as cities and streets, any satisfactory effect, or even be without offence, until we have arrived at a much greater harmony of treatment than now prevails; but it is also impossible, we believe, that the communities who live in them, and who must in the mass form their taste upon them, should judge fairly of their architecture till their eyes are used to harmonious general effects, and trained by the habitual sight of some prevailing and consistent style. In fact, we doubt whether the mass of men can be educated to judge of any art, except they get their first training in design by constant association with some limited range of forms consistently combined and treated: nor do we believe that architects as a body, whatever may be the success of single men of exceptional gifts, can attain a mastery of design such as marks the interesting periods of architecture, except by working sedulously and unitedly in the developement, conscious or unconscious, of a definite style, or even that the individual ever reaches the full measure of his power, unless by persistent study of the combinations of a limited series of related forms, that is, by following out a distinct style. At any rate,—and this is our present point,—they cannot expect to succeed as a profession in leading the public taste, so long as they will pull in a dozen different ways.

The remedy would seem to be a closer association with each other, not simply for offence and defence, but for improvement. A profession in which every member works alone in his own way, not sharing his aims or his experience with his fellows, as was the case in ours a few years ago, does not deserve to be called a profession. The most progressive profession among us, the medical, owes its success largely to the fact that the efficient members of it live in constant intercommunication of ideas. Those who stand aloof and practice in their own way, without common study or consultation, are, for the most part, those who are known by the significant name of "quacks." Fortunately the establishment of the American Institute of Architects, and its various affiliated branches, with the formation of other clubs for like purposes, has done much to remove the greatest reproach of the profession. The establishment of architectural schools is working in the same direction. Interchange of ideas and experience the stimulus of common study and criticism, the contagation of a hearty interest in the same problems, and in the advancement of a common object, will be the most powerful influences in giving character and unity to our work, as well as in establishing the taste, and insuring the support, of the public. We have ability, training, individual discipline, among our architects; there is every incentive and every opportunity for a vigorous develeopement. But, so long as the professional trumpet gives an uncertain sound, we cannot wonder if it fails to command a loyal following.—*The American Architect and Building News.*

THE ST. GOTHARD TUNNEL.

BY D. K. CLARK, M. INST. C. E.

[CONTINUED]

ROCK-BORING MACHINERY.

The machinery for boring the rock in the tunnel consisted of two distinct parts—the perforators, or rock-drills, and the air-compressing machines, for supplying compressed air to work the perforators.

AIR-COMPRESSING MACHINERY.

Temporary machines, constructed by the Cockerill Company, Seraing, were at first erected, capable of supplying 77 cubic feet of compressed air per minute; this quantity was sufficient to work twelve perforators. At each end of the tunnel, a pair of horizontal direct-acting steam-pumps were laid down. The steam-cylinders were 19.7 inches in diameter, and those of the air-pumps, 17.73 inches, with a stroke common to both, of 3.64 feet. The flywheel was 16 feet 9 inches in diameter, and its weight was 6½ tons. The air-pumps worked in water similar to Sommeiller's pumps at the Mont Cenis Tunnel. The minimum speed was five revolutions per minute, cutting off steam at half stroke; but the machine could make twenty turns, equivalent to a speed of piston of 158 feet per minute. The compressed air was delivered into a reservoir 5 feet in diameter and 29 feet long. The volume of air compressed per stroke of the piston was 1.52 cubic foot, under a pressure of 3 atmospheres; and, at a speed of twelve and a half turns per minute, 77 cubic feet of compressed air had been supplied per minute. The work done for one stroke of the pump, measured from indicator diagrams, was

	Foot-lbs.
For the steam-cylinder	32,790
" air-pump	27,550

The work done in the air-pump was thus 84 per cent of the indicator power.

The temporary air-compressors were kept regularly at work until November 1873, when they were placed in reserve, and one of the permanent compressors was substituted.

PERMANENT PRIME-MOVERS, AND AIR-COMPRESSORS.

The power is derived from water, through the agency of turbines. At the south end, the supply of water was found to be scarce—sometimes as low as 67 gallons per second—and it became necessary to work under a fall of nearly 600 feet, which was reduced by losses to 531 feet at the turbines. At the north end, the minimum supply is from 570 to 444 gallons per second with a fall of 385 feet. The power at each end was at first received by three turbines, each turbine driving a group of three air-compressors: in all nine compressors at each end. Two more turbines and groups of compressors were laid down at each end of the tunnel towards the end of 1874, to make up a full supply of air for the number of perforators then at work.

SOUTH END.

The turbines at the south end were constructed by Messrs. Escher, Wyss, and Co., of Zurich. They are horizontal, on vertical shafts. The crown is of bronze, cast in one piece with one hundred blades. The exterior diameter is 3.94 feet, and the total thickness is about 11 inches. At full power, the wheel makes three hundred and ninety turns per minute; when the circumferential velocity is 80 feet per second. The distributor and the directing vanes are of bronze. On the upper end of the shaft of each turbine, a bevel pinion is fixed, and it gears into a large bevel wheel fixed on a horizontal shaft formed with three throws or cranks to work the compressors of one group. The turbines are ranged in line, and the horizontal shafts, pertaining each to one turbine respectively, are coupled together end to end, and so united into one continuous shaft. The work done by the several turbines is thus distributed equally over all the groups of compressors.

The three compressors of each group are connected at equal angles round the shaft, and are fixed on one base-plate. The cylinders or pumps are 18.1 inches in diameter; the stroke is limited to 17¾ inches, in order that the mean speed of piston may not exceed 266 feet or ninety revolutions per minute, when the turbine makes three hundred and ninety turns. The compressed air is cooled on Dr. Colladon's system: every piece that is in contact with the air when undergoing compression is cooled by currents of cold water passed through air tight envelopes; the piston-rod is tubular, and is filled with cold water, which is circulated within it, and is at the same time extended to the interior of the piston. Water is also injected into the cylinder in fine spray; and for this purpose it is doubly filtered, so as completely to separate the fine granite sand brought down by the Alpine torrents.

The clearance at each end of the air-pump does not exceed ¼ inch; yet there is no liability to shock or concussion within the machine. The ingress and egress valves are inserted in the covers at the ends of the cylinder, and are closed by the action of helical springs. The area of opening of the ingress valves is .1 that of the piston, and of the egress valves .05. The egress valves are placed low, so as to permit of the simultaneous ejectment of the compressed air and the injected water at each stroke. The quantity of injected water on this system is less than .001 part of the volume of the air drawn in; and it is not more than one-fourth of the water which had been requisite in working the water-piston of the temporary pump.

The density of atmospheric air at such high levels is much less than at the sea-level. By the barometer, it is only 87 per cent.

The compressed air from the pumps is discharged into four reservoirs, each 5.3 feet in diameter, connected successively with each other by pipes. Into the first of these the air and water from the pumps are delivered; there the water is separated, and the air passes into the next reservoir, and so on successively. The succession of reservoirs serves to break the waves of pressure from the compressors. The capacity of each reservoir is about 600 cubic feet. The effective pressure is 7 atmospheres.

NORTH END.

The Girard turbine is employed at Goeschenen; the turbines were constructed by B. Roy and Co., Vevey, who considered that the Girard turbine was capable of utilizing, with the best effect, variable quantities of water. With 279 feet of fall, and a maximum charge of water of 67 gallons per second, an effective power of 250 H P. could be realized. The performance, when needed, may be raised to 280 H P., in case it may be occasionally required to elevate the pressure to 10 atmospheres. The turbines are 7 feet 10½ inches in diameter; they have eighty buckets, and their regular speed is one hundred and sixty turns per minute.

The production required from each group of compressors was 4 cubic metres, or 141 cubic feet, of compressed air, at an effective pressure of 7 atmospheres. For this rate of delivery, the compressor-shaft was timed to eighty turns per minute; the diameter of the cylinders was fixed at 16.5 inches, with a stroke of 25.6 inches. For three compressors of one group the quantity of air drawn in would be 1.483 cubic feet per minute.

The piston of each compressor and its rod are hollow, and they are cooled by cold water circulated within them, on Colladon's principle. Cold water is also admitted through the periphery of the piston, which is 7 inches deep, and recessed in the middle to hold a stratum of the fluid. The fluid under a pressure greater than that of the compressed air, laps the interior surface of the cylinder, and effectually cools it. A portion of the water passes by the piston into the cylinder and cools the air.

The air is drawn into the compression-cylinders through two inlet valves in the upper part of each cover, and is discharged, together with the water collected in the cylinder, through three other valves, of less diameter, placed in the lower part of each cover, into a small receiver at one end of the cylinder. A float in the receiver, in connection with a cock, forms a self-acting arrangement for letting off a portion of the water collected in the receiver from time to time, thus preventing the water from rising to an inconvenient level. The compressed air is conducted from the upper part of the receiver into large reservoirs.

TOTAL QUANTITY OF AIR PROVIDED FOR, TO BE DELIVERED IN THE COURSE OF TWENTY-FOUR HOURS.

	At Atmospheric Pressure. Cubic feet.	At Eight Atmospheres. Cubic feet.
At the south end	4,941,000	917,625
At the north end	6,349,000	793,625
	11,290,000	1,411,250

PERFORATORS OR ROCK-DRILLS.

Dubois and Francois' perforator, the first machine employed in the excavation of the tunnel, is based on the principle of Sommeiller's perforator, used at the Mont Cenis Tunnel, but it is simpler in construction. There are four motions in the machine: 1st, the delivery of the blow; 2nd, the turning of the jumper on its axis after each blow; 3rd, the advancement of the drill to follow up the work; 4th, the withdrawal of the machine when the tool or the machine itself is to be changed, or when the hole is completed.

The diameter of the percussion-cylinder is 2.76 inches, and of its piston rod 2 inches; the length of stroke varies from ¾ inch to 7.2 inches. The weight of the percussion-piston, with its rod, is 62 lbs; the total weight of the machine is 4½ cwt. The length, width and height of the machine are 7.2 feet by 9.2 inches by 12.6 inches. The boring bars which are keyed to the piston-rod of the perforator, are of steel, octagonal in section, and 1 inch in diameter over the angles. In hard rock, they work well at a length of 4 feet; in soils of medium hardness a length of 5 feet is suitable; and in easy rocks a length of from 6 to 6½ feet. The capacity of the cylinder is 79.3 cubic inches, and the quantity of compressed air consumed per stroke is 97.6 cubic inches.

Ferroux's perforator, which, for the most part, superseded Dubois and Francois', by reason of its superior performance, contains an automatic movement by which the percussion-cylinder is advanced spontaneously, and keeps pace with the progress of the hole. In Dubois' machine, the advance was conducted by hand, and, for want of exactness in manipulation, frequent damage was occasioned to the cylinder by knocks and wrenches—a species of accident which has seldom happened to Ferroux's machine.

The automatic movement in Ferroux's machine consists of an air-cylinder fixed behind and on the centre line of the percussion-cylinder, having a piston and rod conected to the head of the percussion-cylinder. The piston of this, the propelling cylinder, is constantly under the pressure of compressed air, by the agency of which the percussion-cylinder is moved forward when freed to be moved, and is kept taut to its bearings in front when at rest. These bearings consist of a pair of ratchets, the forks of which are engaged in the teeth of two racks, one on each side of the machine. The teeth of these racks are placed at 1.2 inch pitch, and they measure the successive steps of the advance of the percussion-cylinder. When it becomes necessary to advance this cylinder a step, the rachets are raised clear of the racks, and the cylinder is instantly moved forward by the force of the air on the piston of the propelling cylinder behind it. The ratchets fall into the next notches of the racks, and are there set fast by the propelling pressure, untill they are again lifted for the next advance. The raising of the ratchets at the right time is effected by a collar on the percussion piston-rod, which strikes a tappet in connection with them, and raises them just as the stroke of the drill reaches its appointed maximum length. The percussion-cylinder is secured behind by another pair of ratchets, which engage in two other racks on the frame, the teeth of which turn the opposite way. The ratchets are set fast in the racks by the pressure of compressed air. By these means the percussion-cylinder is maintained perfectly steady whilst in action.

The slide-valve for distributing the air to the percussion-cylinder is moved by an eccentric on a longitudinal traversing shaft which passes over the whole length of the machine. This shaft is turned by means of a short vertical cylinder at the head of the machine, 3.6 inches in diameter, with a stroke of 2.8 inches. The speed at which this shaft revolves regulates the rapidity of the drill. At the same time, the independence of the movements of the valve with respect to those of the drill-piston gives rise to frequent false strokes, which cause a waste of air.

At the extreme end of the machine this shaft carries an eccentric, which by means of a ratchet, gives to a wheel on the percussion-rod a definite portion of a turn for each stroke, and thus the revolving movement of the drill is effected.

The percussion-cylinder and its appendages can be instantly withdrawn from the front, by the pressure of the compressed air being reversed on the propelling piston. The diameter of the percussion-cylinder is 3.36 inches, and of its piston rod 2.8; the maximum length of the stroke is 6.4 inches. The diameter of the propelling cylinder is 3.2 inches, and of its piston-rod 2 inches. The total weight of the machine is 4.91 cwt. The length, width, and height of the machine are 10 8 feet by 10.4 inches by 14.4 inches. The capacity of the percussion-cylinder is 104 cubic inches, and the quantity of compressed air consumed per stroke is 140 cubic inches. When regularly at work, the machine makes from two hundred and fifty to three hundred strokes per minute.

COMPARATIVE PERFORMANCE OF MECHANICAL PERFORATORS AT THE ST. GOTHARD TUNNEL.

From the results of trials made early in 1874, in boring holes 35 centimetres, or 1.4 inch, in diameter, in the granitic gneiss at the north end of the tunnel, with an effective pressure of 5½ atmospheres, the following were the depths per minute bored by the perforators of different constructors, according to official reports:

	Centimetres.		Inch.
Ferroux	4.01	or	1.60
McKean	3.50	"	1.40
Dubois and Francois	2.60	"	1.02
Sommeiller (Mont Cenis)	2.12	"	0.85

From other observations made and officially reported, in the beginning of 1875, the following were found to be the lengths of time required by one of each system of perforator to bore a hole 1 metre (3.28) in depth. In these times, all the delays occasioned by the changing of jumpers, machines, etc. are averaged and included:

	Total Length Driven. Metres.	Machine.	Time to bore 1 m. by one machine. Hr.	Min.
Advanced gallery, north end	6,352	Ferroux	1	9
Trench "	4.226	Dubois	1	31
Advanced gallery, south end	2.617	"	1	24
Widening " "	623	Sommeiller	2	54
Trench "	205	McKean	2	1

It is added that the cost for repairs of the perforators working at the north end, during the three months, October–December, 1874, was, per metre of holes bored, as follows:

Ferroux's perforator 2.43 francs per metre, or 1s. 9d. per yard.
Dubois' " 4.27 " " " 3s. 1d "

In the course of the present year, 1875, considerable improvements have been made in the McKean drill, and it is stated in an official report by M. Louis Sautter that after a series of comparative trials in boring the hard granitic gneiss, the performance of the improved McKean drill proved to be decidedly superior to that of any of its competitors. M. Favre has provided himself with sixty of these drills for future operations. The body of the drill is cast of phosphor-bronze. The air-cylinder is 4 inches in diameter; the piston is of wrought iron, 2 inches thick, fitted with two pairs of Ramsbottom's rings. The piston-rod is 2¼ inches in diameter, and screwed and pinned into the piston. The maximum stroke of the piston is 5 inches; the minimum stroke is 2 inches, and the average length of stroke when at regular work

is 3½ inches. The machine can bore to a depth of 3 feet at one setting. The drill is, of course, worked by compressed air, and it is calculated that 62 cubic inches of air are used for a stroke of 4 inches. The drill can be moved with half an atmosphere of pressure, and it is capable of making from 500 to 700 strokes per minute, with air of 5½ atmospheres of effective pressure. The total weight of the machine is 506 lbs. It is 7 feet 6 inches long, and 10 inches by 9 inches in width and depth, extreme dimensions. At the comparative trials above referred to, the drill penetrated, whilst actually at work, from 3 to 8 inches per minute, making 800 strokes; with 6½ atmospheres of pressure, it has penetrated as much as 12 inches in a minute.

The turning movement of the drill is effected by means of a cylindrical enlargement formed on the piston-rod. Spiral grooves are cut on the face of this enlargement, which is constantly in gear with a spirally-grooved cylinder placed parallel to the piston-rod, and capable of revolving. On the return stroke of the piston, the cylinder is maintained by a ratchet-motion in a fixed position, whilst the piston rod, sliding upwards in a gear with the cylinder, is necessarily turned on its axis, to a degree proportionate to the twist of the spiral, and the length of the return stroke. Thus the new angular position of the jumper is secured. During the forward stroke, the spiral cylinder does not influence the piston-rod, which moves straight forward, and, on the contrary, turns the cylinder on its own axis. Nevertheless, as a precaution, the piston-rod is prevented, by a ratchet-motion, from returning to its previous angular position, in making the forward stroke. On the next back stroke, the piston-rod is again seized by the spiral cylinder, which is now brought up against its ratchet-detent, and is turned round as before, preparatory to making the next forward stroke.

The compressed air is supplied to and exhausted from the cylinder through a hollow cylindrical valve formed with suitable openings. For this purpose the valve receives an oscillatory movement on its axis, by means of tappets fixed on its spindle, which are moved alternately to the right and to the left, on the forward and backward strokes respectively, by the enlargement on the piston-rod. The ends of the enlargement are formed conically, in order to move the tappets steadily and fairly.

The action of the enlargement on the tappets is also utilised for effecting the feed or advance of the jumper. The reciprocations of the forward tappet are communicated to a lever fixed to one of a pair of crown ratchet-wheels placed together on a screwed spindle, and held in gear with each other, like clutches, by a helical spring. The first of these, the lever-wheel, reciprocating in unison with the tappet, is loose on the spindle; but the second is feathered and engages in a longitudinal groove cut in the spindle. Thus as the second wheel is turned, it turns the spindle with it, which, by the screw, advances the cylinder. The teeth of the first wheel slide over those of the second wheel in one direction, and engage them in the opposite direction. When, therefore, in the ordinary course of reciprocation, the first wheel is pushed round far enough by the tappet movement, it advances its hold upon the second wheel, by the interval, usually, of one tooth at a time, and, when withdrawn, it pulls round the second wheel and the screw with it, which gives the feed Should the first wheel not be pushed round far enough by the tappet-movement to gain a tooth, the teeth of the first wheel slip back into the same places and no advance is made. But the play of the tappet is increased as the stroke increases with the penetration in virtue of the conical form of thr surface of the enlargement; so that, finally, when the length of the stroke has reached the maximum designed for it, the first wheel is advanced far enough to gain a tooth upon the second, turns it, and gives the feed. As there are fifteen teeth in each ratchet-wheel, each advance of one tooth is equal to a fifteenth of a revolution, and the pitch of the screw, formed with a double thread, is 1 inch. Consequently each advance of the feed by one tooth is just one fifteenth of an inch. By this simple combination of the double ratchet-wheel and the screw, the feed is thus minutely graduated, and the stroke of the piston, on regular work, becomes practically constant.

The McKean drill recommends itself by its simplicity, efficiency, and completeness. The whole of its functions originate in the simple enlargement of the piston-rod, from which the twisting motion, the feed motion, and the valve motion are derived.

The following are the leading particulars of the three most prominent perforators that have operated in the St. Gothard tunnel:—

Perforator.	Diam. of Cylin.	Stroke.	Air consumed per Stroke.	Wt.	Dimensions.		
	In.	In.	Cub. In.	Cwt.	Ft.	In.	In.
Dubois	2.76	0.75 to 7.2	97.6	4.33	7.2 x	9.2 x	12.6
Ferroux	3.36	max. 6.4	140.0	4.91	10.8 x	10.4 x	14.4
Mckean imp.	4.0	2 to 5	62.0	4.52	7.5 x	10.0 x	9.0

It is intended to perform the work of perforation entirely by machine dispensing with hand labor. The area of the tunnel will be divided into seven sections: three on the upper level,—the level of the floor of the heading; and four on the lower level,—that is the floor of the tunnel. The culvert constitutes an eighth, and smaller section. Each of these sections, separately, will be attacked by a group of perforators, as follows:—

	Number of Perforators.
The heading, or *avancement*	6 to 9
The right wing of the heading, widening out or *abatage*	3 to 5
The left wing of the heading, widening out or *abatage*	3 to 5
The shallow trench in the core, or *petite cunette*	2
The deepening of the trench to the floor of the tunnel, or *grande cunette*	6 to 9
The greater mass of the core to the right of the trench, or the *strosse*	6 to 9
The narrower mass of the core to the left of the trench, or *piedroit*	3
The culvert, or *canal*	1
Total number of perforators at each end	30 to 43

The faces of the several sections will, of course, be at various distances from the front, at intervals of from 50 to 150 metres (55 to 164 yards), one behind another. By such disposition the operations on one section will not be interfered with by those of the others. From the face of the heading to the face of the excavation for the culvert—the last in succession—the interval may amount to 1,000 metres (1,090 yards).

LABOR EMPLOYED.

The numbers of men employed on the works in August, 1875, were as follows;—

	Average Number.	Maximum Number.
North end	1,664	1,902
South end	1,802	1,984
Total employed	3,466	3,886

The composition and the duties of a shift, or 'poste,' of workmen at the advanced gallery, north end, in September 1874, were as follows:—One foreman, four miners, two machinists, eight laborers, one boy; in all, sixteen men at the front. Add for chargers and laborers for removing rock, twenty-two men. Total, thirty-eight men for one shift. For two shifts, seventy-six men; and for three shifts, one hundred and fourteen men.

LOCOMOTIVE POWER.

Since the month of December 1873, a small locomotive, weighing 5½ tons, on four coupled wheels, 1 metre (3.28 feet) apart, has been employed at each end for removing the exploded rock. It was worked by compressed air, and was followed by a tender, consisting of an air-reservoir of 650 cubic feet of capacity, on two bogies. When charged at the commencement of a trip, the pressure was from 6 to 7 atmospheres. After taking a train of twelve loaded wagons, holding 1 cubic metre or 35 cubic feet each, from the tunnel to the place of unloading, a distance of about 600 yards, the pressure fell to about 4½ atmospheres; and after returning with the empty train there was left a pressure of from 2 to 2½ atmospheres.

But, in view of the considerable and increasing traffic in prospect, on a line of railway, in two long tunnels open at each end only, and which will ultimately approach to 3 miles in length, M. Favre has recently replaced these unwieldy machines by more compact and more efficient locomotives, constructed by M M. Schneider and Co., of Creusot, and designed to be worked by compressed air of 15 atmospheres. These engines are like ordinary engines in general arrangement and detail, except with respect to the reservoir, which replaces the ordinary boiler, and consists of a cylindrical steel reservoir for the storage of compressed air. The supply of air is drawn, meantime, from the ordinary compressors at 7 atmospheres, until the special compressors in course of construction are completed, for the supply of air of the higher pressure. The air is admitted into the cylinders at a pressure of 43 lbs. per square inch. These locomotives have worked satisfactorily, and it is suggested by M. Ribourt that compressed-air locomotives may be employed with great advantage for working trains through long tunnels, in place of locomotives worked by steam, thus dismissing the unsolved problem of the artificial ventilation of tunnels.

The quantity of broken rock removed from each end of the tunnel amounts in bulk, according to M. Ribourt, to about 530 cubic yards daily; and, as each large wagon holds 1 cubic metre, or 1½ cubic yard, the daily traffic consists of four hundred wagons each way in the twenty-four hours. To this number is to be added forty wagons or trucks for the conveyance of building material, and ten trucks for conveying jumpers and perforating machines to and from the front. The total of this daily service represents the movement of 2,300 tons daily at each end.

TEMPERATURE IN THE TUNNEL.

The temperature at the front increased slowly as the heading was extended, but it was not much affected by the depth below the surface.

The temperature of the rock was measured by inserting thermometers into holes cut to various depths. In July 1875, at 1 foot deep, the temperature was 63° Fahr.; at 2 feet deep, 63°.55 Fahr.; at 3 feet 3 inches deep, 64°.7 Fahr.

VENTILATION OF THE TUNNEL.

The ventilators at the north end were reported in the end of June 1875, to be nearly completed and ready for ventilating the tunnel. They act by exhaustion, on the system of the bell-exhauster. Two bells of sheet iron, 16 feet 5 inches in diameter, with 5 feet 11 inches of stroke, are connected by an oscillating beam. from the end of which they are suspended, and on which they balance each other. They rise and fall alternately over fixed bells closed at the top with water-joints, and, when fully charged, draw about 2,060 cubic feet of impure air by each double oscillation. Allowing for the partial vacuum formed within the bell, and for short measure, they should make ten double oscillations per minute to discharge 16,500 cubic feet of air per minute, which is the estimated volume of mixed air and gasses to be withdrawn. The air from the interior of the tunnel is conducted through a tube, 4 feet 10 inches in diameter, placed close to the soffit of the arch, and extended inwards as far as the arching is completed. The bells are moved by water-pressure acting in cast-iron tubes fixed centrally within the bells.

It may be added, in conclusion, that the whole of the works of the St. Gothard railway are under the superintendence of Herr R. Gerwig, of Carlsruhe, who is Engineer-in-Chief of the line. The axis of the tunnel, with its length and the difference of altitudes between the two ends, were surveyed and definitely settled by Herr Otto Gelpke, mining engineer, Berne.

Silicate Cotton.

This new material for covering boilers, steam-pipes, etc., although not invented, has been brought prominently into use, by Mr. F. Krupp, who has applied it largely at his steel works at Essen, Prussia, with highly satisfactory results. It is incombustible, and altogether appears well adapted for its purpose as a non-conductor of heat. It is made at the large furnaces for converting the ironstone into pig iron, where the slag is kept continually running out at a small opening, about one inch in diameter. From thence it travels through an open spout, and falls from the end about thirty inches, at which point a pipe coming from the blast chamber is fixed. The rush of cold air, coming in contact with the melted slag, drives it into thousands of fine hair-like threads, resembling fine spun glass, or asbestos. Although it has much the appearance of cotton wool, the fine points of the fibers, if much handled, pierce the skin like so many fine needles. The material is being introduced in England.

Notes.

English capitalists are ahead on the negotiations for railway and other monopolies in Egypt.

A company of surveyors are prospecting for a railroad from Coal Valley to the coal lands of Cable & Co., near Richland, Ill.

The Interoceanic Canal Commission, after discussing the reports on six different lines, have unanimously recommended the Nicaraguan route for the Isthmus Ship Canal. The length will be 181 miles, and the estimated cost $66,722,147.

The Western Union Telegraph Company are about laying a Pneumatic Tube between their offices in New York. It will be of lead, 2¼ inches in diameter, enclosed in a 3 inch iron pipe for protection. The carriers will be of gutta-percha, covered with felt.

They say the alarming increase in the death-rate of the City of Washington is due to imperfect sewers furnished by the District Ring Contractors. It is claimed that the contractors filled in the sewer trenches with impervious clay and sold the gravel which they had taken out, and which afforded ready drainage to surface accumulations. In this way the natural drainage of the soil —which at Washington has always been excellent—has been broken up and clogged.

It has been known that, when explosive gases are drawn through a wire gauze with a velocity of ten to twelve feet per second, the flame of a safety lamp will penetrate and ignite them. GALLOWAY has now proved by experiment that a sound-wave will cause the same explosion. He therefore came to the conclusion, which accounts for a number of explosions in mines at the moment of firing a blast at a distance, that a blast in a coal mine may make all the safety-lamps useless. This fact also explains why an explosion in one part of a mine is often immediately followed by another explosion at a distant point.—Abridged from "*The Laboratory*."

A survey has just been completed for a proposed railroad line extending from St. Paul to Rochester, Minn. It is to be built in the interests of the L. S. & M. R. R., and to be narrow guage,—three feet. The grades and curves are comparatively easy, and the total length of the line is 85 miles. It is proposed to cross the Mississippi by means of a pontoon bridge. The building of the above road would open up the best wheat-growing portion of the State, and give to shippers of that district the best outlet they could have,—by way of the lakes—and direct communication with Eastern markets.

ENGINEERING NEWS.

SATURDAY, FEBRUARY 12th, 1876.

GEO. H. FROST, - Editor and Publisher.

108 Washington Street, Chicago, Illinois.

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MULTIPLE TELEGRAMS.

We presume that our readers are familiar with the essential points of the common method of sending telegraphic despatches over a wire. The circuit being completed at one end by the depression of a key, the electric current, passing through the coil of an electro-magnet at the other end, causes an armature to close on the magnet. A projecting arm from the armature strikes against a piece of metal so as to give the sound usually heard, or a point impresses a mark of greater or less length on a moving strip of paper. The repetition of the long and short depressions of the key, combined in different ways, makes the alphabet. This message will be delivered in all the offices which are at the time connected.

Impulses may be sent from different ends, as they meet and pass one another without hindrance. As the electric current is practically instantaneous, it would be possible, in lines of not too great length, to have the signals follow one another with great rapidity. Such a result has been produced by delicate apparatus, to take the place of the operator, so that several messages can now be sent over the same wire in the time formerly occupied in sending one; and, as before stated, they may be sent opposite ways.

If we can utilize a single wire for a number of simultaneous messages, without requiring such special appliances as are delicate and easily deranged, we save in the cost of lines and consequently make the telegraph still more convenient for common use. Very recently an apparatus has been brought out which, availing itself of some facts previously known, enables a great number of despatches to be sent at once, without confusion. They may be sent from the same or different offices, and received at the same or different places. Each receiving instrument picks out the message destined for itself.

We know that two or more different sounds may move through the air, wood, wire, or other media without interference. Voices or instruments may sound together with no confusion; every vibration or wave travels independently. One may easily illustrate this fact by agitating the surface of water at different points. It has also been shown by placing one end of a slender stick on the sounding-board of a piano-forte, taking the other end in the teeth, stopping the ears, and then having the instrument played.

Paul la Cour, of the Royal Meterological Institute, Copenhagen, has exhibited a new system of telegraphing the sonorous vibrations of a number of tuning forks placed in electric connection with each other. The pulsations or vibrations sent over the wire are distinct, but for a particular musical note their number is fixed. The ear cannot distinguish the individual vibrations, and they merge into a continuous sound. If then we send the pulsations over the wire and attract the armature at the other end the proper number of times for a musical note, it will be produced there by a fitting arrangement for a *sounder*. We then avail ourselves of another principle.

All have noticed how, when a note is sung near a piano or sounded on another instrument, certain strings in the piano will respond, one more loudly than the others. This arises from the fact that its normal rate of vibration agrees with the rate of the note first sounded, so that the successive impulses through the medium of the air excite the vibration of the string. A very small force is needed to produce this effect, just as the escapement of a pendulum keeps the latter swaying. Suppose then, a tuning fork to be placed in the circuit at the despatching end of the line, so that, either when made mechanically to vibrate, or when set in motion by the attraction of an electro-magnet, it shall send a succession of impulses through the wire. If a tuning fork pitched to the same note, is now put in place of the armature at the receiving end, this latter fork will be caused to sound, by being attracted and set free again, and will give to the ear its musical notes. This note will sound as long as the first fork vibrates in the circuit, and consequently these notes, long and short, take the place of the usual alphabet. The sound may be increased in volume by placing the fork on a sounding-box. If the latter fork, however, were not tuned to the same note as the former, the impulses or attractions would not come over the wire at the proper minute intervals of time for that fork, and consequently they could not arouse and intensify the movement of the small steel bar so as to make it give its note.

It will be readily seen then, that if, at the receiving end, the wire branches to a number of tuning forks, only that one will speak which is in unison with the one at the other end. And as the impulses do not interfere with one another, several forks at one end may be sounded or put into circuit simultaneously by different operators, and each fork at the other end will respond only to its own message. The case is not altered if the different forks are at different parts of the line.

This discovery has recently been utilized in this country by Mr. Gray, with what he calls a "Telephone," and it may indeed be an independent invention. Mr. Gray uses musical reeds, that is, small springs, such as are employed in a clarionet and some organ pipes, which set in vibration a column of air in a tube and thus cause a note to be sounded. Experiments were quite recently made, and with great success at Milwaukee, in sending eight simultaneous messages through a single wire. We copy a description of the apparatus given in the *Spectroscope:*

"Each reed is vibrated constantly, by electro-magnets, actuated by a small battery. An ordinary Morse telegraph key, is introduced in the circuit, which, when at rest, prevents the passage of the vibrations, but when depressed by the operator, allows the vibrations of the current to flow to the line.

"At the other end of the line, are a number of electro-magnets, mounted on boxes, tuned to vibrate in unision with the reed that controls the vibrations of current at the sending end. On the top of each of these electro-magnets, is placed a small steel reed, similar to its fellow at the sending end of the line.

"Now for the operation. Take one sending reed, whose natural rate is, say, five hundred per second. The operator depresses the key and the reed sends five hundred electrical waves or impulses per second through the wire.

"The cores of all the receiving magnets at the other end, are agitated by the incoming current, but none of the reeds are set in vibraion, except the one whose fundamental rate is the same as the sending reed. The box on which the magnet and reed are mounted, takes up the vibrations, and setting the column of air inside, in motion, the sound is amplified, and the note pours forth clear and loud, from the open end of the box. This sound, broken into Morse dots and dashes, by the sending operator's key, is read by the operator at the receiving end. The same explanation applies to any number of tones sent at the same time.

"This vibrating reed at the receiving end may be made to open and close an ordinary telegraph sounder. In this case, the receiving operator hears the Morse dots and dashes, as in the old system."

BUSY MEN.

Fully occupied as the time of most business men of Chicago is, yet some of the very busiest of them find opportunities to increase their own and the world's knowledge in the fields of scientific research. The Address of President Johnson, of the Academy of Sciences, in retiring from the office which he has so long and ably administered, is a partial review of what has been accomplished by that body, in Chicago, during the past few years, notwithstanding the serious drawbacks in the shape of being twice burnt out; of losing their very efficient Secretary and Curator, Dr Wm. Stimpson, by death; and of being retarded in progress by the financial stringency of the times, which affects the patrons of the Academy in common with the rest of the business community. We shall take an early opportunity to sketch the history and progress of this truly noble monument to the liberality and persevering energy of some of the business men of Chicago; at present, we wish only to to mention the names of some of the leading workers in the scientific department of the Institution. They are all busy men:—Dr. Andrews, Past President, is a leading surgeon of the Northwest, yet amid the constant demands upon him for professional services, finds time for geological exploration and study, so as to place him in the foremost rank of geologists in this country; Dr. Johnson, Past President, is a leading physician of this city, but has found time for original research in the highest departments of microscopy; Prof. Babcock, while engaged in regular professional duties, in connection with his Academy, finds time to take charge of the Botanical Gardens of the South Park Commission; Prof. E. Colbert, while discharging the laborious and responsible duties of Commercial editor of the *Tribune*, is yet the leading spirit of the Astronomical society of this city; is Professor of Astronomy in charge of the Dearborn Observatory, where he spends a large portion of every clear night; delivers frequent lectures on scientific subjects before various societies; keeps abreast with the Astronomical discoveries of the day, and still steals moments enough from his busy life to enter upon the most abstruse calculations of the higher mathematics, as witness the very simple and compact formulæ for the determination of the areas of the Conic Sections which we give in our report of the last meeting of the Academy, but which are the result of nearly *three years* labor of Prof. Colbert, and which have never yet been published from any other source that we are aware of; and S W. Burnham, while attending to the management of the largest corps of official court reporters in this city, has been able to win such a world-wide celebrity as a double-star observer, as to merit his election to the membership of the Royal Astronomical Society of England, and to make him a corresponding member of various scientific societies, the latest of which honors is that by the Wisconsin Academy of Sciences, at Madison, which was conferred only last week.

There are other indefatigable members connected with the Academy of Sciences to whom that institution is very justly indebted, and to whose special labors we will refer at some future time. We have enumerated the above as special instances of the profitable employment of moments snatched from the engrossing cares of professional and commercial life.

TORONTO CORRESPONDENCE.

In this good city of ours—the Capital of the Province of Ontario—a city of some 80,000 inhabitants, Sanitary Reform is the object claiming, at present, the largest share of public attention. As a first step in that direction, the people are calling for a complete system of sewerage; and the City Council has been extremely fortunate in securing the services, as City Engineer, of Mr. Frank Shanly, one of the brothers Shanly, the Canadian Engineers who completed the celebrated Hoosac Tunnel.

The old Water Works having proved insufficient to meet the demands of the rapidly growing city, new Works are now in progress. $1,100,000 has already been spent, and $900,000 additional has recently been voted by the rate payers. It is as yet questionable whether the $2,000,000 will be sufficient to complete the work. I shall at as early a day as practicable endeavor to give you a brief sketch of the Works. Mr. P. A. Peterson is Chief Engineer, and Mr. Thos. Keefer, of Ottawa, Consulting Engineer.

Efforts, likely soon to succeed, are now being made by some of our leading citizens, to establish in this city, a large iron smelting and manufacturing concern. We have, within 100 miles of the city, vast quantities of the best of iron ore, with direct railway communication. Hitherto our iron ores have been mined only for shipment to Cleveland, Pittsburg and Charlotte, in the United States. And the success of the iron works in those cities, together with the advantages resulting to the places where such works are located, have stimulated the formation of a strong company here for the purpose of utilizing our resources. With unlimited supplies of ore and the requisite flux near at hand, and with the facilities for getting coal by land or water enjoyed by this city, argument is unnecessary to show prospects of almost certain success in this enterprise.

The following extract from the Annual Report of the Toronto Board of Trade, presented at the meeting of that body held here on the 1st inst., may be of interest as showing the present condition of railways in this

Province, either completed or in process of construction:

"In railway affairs we have to note great depression. Lines in operation are in most cases doing the carrying trade at a loss, while those under construction—the promoters of which, in their inception, anticipated the sale of bonds to such a limited amount as would finally finish and equip them—find themselves now compelled to ask for further Government assistance. This in a great degree is due to the unfair criticism by the English press of our railway policy, basing their judgment as to cost on the outlay put on old lines. Thus ignoring the fact that good lines of railway have and are being constructed for one-third the cost of those first projected, and that, too, on a much better financial basis, as with municipal bonuses and cash capital equalling two-thirds of the cost a good guarantee for the bonds is presented."

A new line of railway of great importance to this Province, and to Toronto in particular, is to run from Toronto as directly as possible to Ottawa City, the Capitol of the Dominion. The line is projected chiefly in the interest of the cities of Montreal and Quebec; the object being to secure through the "North Shore Railway" and the "Northern Colonization Railway,"—both under construction along the northern shores of the St. Lawrence and the Ottawa rivers respectively—direct connection with Toronto, Detroit and Chicago, independent of the "Grand Trunk Railway."

CANADENSIS.

TORONTO, 4th Feby., 1876.

GRAPHICAL ANALYSIS OF ROOF TRUSSES.

BY CHAS. E. GREENE, A. M., PROF. OF CIVIL ENGINEERING, UNIVERSITY OF MICHIGAN.

IX.

Turning to Fig. 20, we see that when the rafters do not slope directly from the ridge to the eaves, but are broken into two or more planes of descent, we shall have wind pressures of different directions and intensities on the two portions, I C and K B. After drawing the steady load diagram, the method of finding the supporting forces which resist these two wind pressures will claim our attention. To make an example for practice we will state that this truss drawn to a scale of 40 feet to an inch, is 50 feet in span, height to ridge 20 feet, and to hips 14½ feet. The sides K B and G E are practically 16⅔ feet long, at an angle of 60° with the horizon, so that their horizontal projection is 8⅓ feet. The upper rafters are 17½ feet long, and therefore make an angle with the horizon of 18° 19′. The trusses are 8 feet apart, and are loaded at the joints only. The rafters would commonly be supported at intermediate points; but more lines would make our figures less plain.

The steady load is taken as 12 pounds per square foot of roof surface, or

$(2\times16\frac{2}{3}+2\times17\frac{1}{2})12\times8=6560$ pounds, total load.

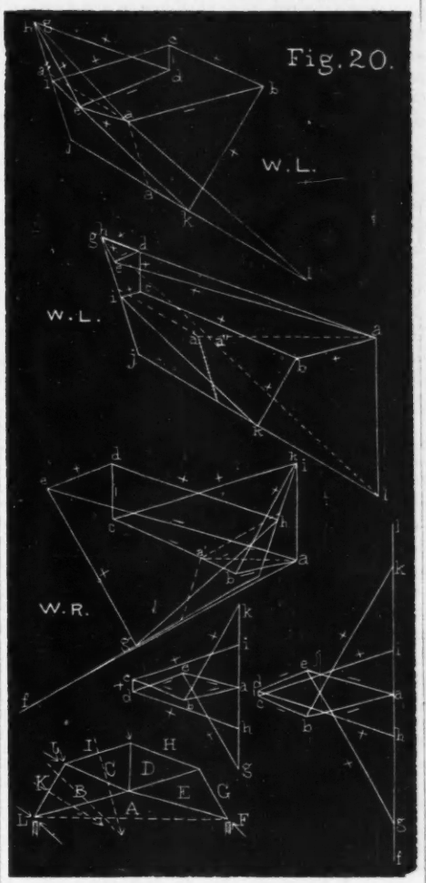
The joint L will carry one half of the load on K B, or 800 pounds, $I K=\frac{1}{2}K B+\frac{1}{2}I C=800+840=1640$ pounds, $I H=840+840=1680$ pounds. etc. These weights are laid off in the diagram, on the right, for steady load, from *l* to *f*, by a scale of 3,000 pounds to an inch. The diagram is now drawn without difficulty. The tensile stresses are marked —, and the compressive ones +. This diagram makes the rafters in compression and all the braces in tension.

In treating this truss as loaded with snow, it is considered that K B and E G are too steep for any weight to accumulate there, as whatever snow fell on them would soon slide off. Therefore a weight of 12 pounds per *horizontal* square foot is taken as the maximum snow load for the upper portion, and, as the horizontal projection of I C + D H is 33⅓ feet, that load will be

$33\frac{1}{3}\times8\times12=3200$ pounds,

laid off from *k* to *g*, in the other diagram with a vertical load line. The end portions, *k i* and *k g*, are each 800 pounds, and *i k* is 1600 pounds. The division into two equal reactions at the points of support gives *a*. This diagram much resembles the other, but there is one point worth noticing; the lines of stress, *i c* and *k d* cross in the first diagram, but do not in the second; while the reverse is the case with *e d* and *b c*. The result is that the stress of C D is reversed by the maximum snow load, and as this stress is greater in amount than the one for the weight of roof, etc., C D will be a compression member whenever such a load of snow falls on the roof; and will be in tension when the snow is removed. The stresses from these two diagrams are given in the table below, in the columns indicated, and the kind of stress is shown by the accompanying sign.

Entered according to Act of Congress, in the year 1875, by Charles E. Greene, in the Office of the Librarian of Congress, at Washington.



If the wind blows horizontally from the left, with a force of 40 pounds on a vertical square foot, and the truss has no rollers under either end, the diagram at the top, marked **W. L.**, will be obtained, the wind being taken account of by itself. The polygon of external forces must first be constructed. From the table of wind pressures given in the seventh article, we see that the intensity of pressure on K B will be 40 pounds, and on I C will be 16.9 pounds, normally, per square foot of roof. The total pressure on K B will therefore be

$40\times16\frac{2}{3}\times8=5,334$ pounds,

of which one-half will be supported at the joint L, and the other half at the joint J, as indicated by the two arrows perpendicular to K B. The pressure on I C will be

$16.9\times17\frac{1}{2}\times8=2,366$ pounds,

or 1183 pounds at each joint.

In the upper diagram then, $h i = 1183$ pounds, on a scale of 3,000 pounds to an inch: $i j = 1183$ pounds, and $j k = 2667$ pounds, the two components at J; and $k l = 2667$ pounds, the wind pressure at L. For *i j* and *j k* may be substituted *i k*, if desired, the resultant of these two components.

To find the supporting forces: — Prolong the resultants of the wind pressure from the middle point of each rafter to intersect the line L F. The resultant K will be resisted at L and F by two reactions parallel to it, and proportional to the two segments into which this resultant divides L F, as was shown for Fig. 18. The same will be true of the resultant I. By scale, or from the known angles, it will be found that the resultant K cuts L F at 16⅔ feet, or one-third the span, from L, and the resultant I cuts it at 22.4 feet from the same end. Dividing *j l* at ⅓ of its length, we have *l a′* for the reaction at L, and *a′ j* for the reaction at F. If we divide *h j* at $\frac{22.4}{50}$ of its length, *j a″* will be the supporting force at L, and *a″ h* at F. By drawing the parallelogram *a′ j a″ a* we shall bring the reactions for each wall together, and shall have, for the supporting force at L, or A L, *l a′* and *a′ a*, or their resultant *l a*; and for that at F, *a a″* and *a″ k*, which combined give *a k*, properly called A H in the truss below, since the letters from F to H are not in use at present.

The polygon of external forces, when there is no roller under the truss is therefore *h i*, *i k*, *k l*, *l a*, and *a h*. The completion of the diagram, by drawing lines parallel to the several pieces, will be easy without further explanation. The stresses obtained can be compared with those for steady load, and added algebraically to them for the combined action. That the point *e* should apparently fall on *i k* is only accidental. The signs affixed to the lines will enable one to see readily that the stresses in B C and E A are now reversed, the pressure I K requiring a strut to keep that joint in place. The resultant, however, from the combined stresses on E A is still tensile. The amounts given by this first, or upper, W. L., diagram have not been tabulated, although it might readily be done. In that case it is unnecessary to draw a diagram for wind on the right; for the different members of the truss will exchange stresses symmetrically; that is, A B will have the stress of E A, and E A that of A B; D H of C I, etc. C D remaining the same. The rest of the table could therefore be completed by inspection.

If rollers are placed at L, to allow for movement resulting from change of temperature, the supporting forces will be modified, L A becoming vertical. The second diagram marked **W. L.** shows the effect of this change, So far as drawing the lines of wind pressure *h i j k l*, the polygon, of external forces will be obtained in the same manner as before. We may then draw the parallelogram and locate the point here marked *a′*; then draw *a′ a* horizontally, and we shall get *l a*, the vertical reaction at L equal to the vertical component of *l a* of the first figure.

In case the first diagram has not been drawn, a readier way to determine *l a* will be as follows:—Draw *h l*, plainly the resultant of *h j* and *j l*; then having prolonged the dotted arrows at I and K until they meet, draw a line, parallel to *h l*, through their intersection. This line will give the position of the resultant of the wind pressures, and *l h* is now to be divided in the ratio of the two segments into which the resultant divides the span L F. The point of division will fall at *a″*, where *l h* is crossed by *a′a*, and the point *a* can thus be located without the parallelogram. The work is less as there will be but one point to be determined instead of two This method will not answer for finding the supporting forces, if they are both inclined, as it would give L A and A H parallel to one an other. The reaction at L being *l a* the one at F is *a h*, requiring the resistance of the entire horizontal components of the wind pressure at F.

A comparison of the two **W. L.** diagrams will show that the stress in every piece is changed very decidedly in amount, and that in a number of the pieces the stresses are reversed. Those obtained with the rollers at L are tabulated with their proper signs in the column marked **W. L.**:

TABLE OF STRESSES.

PIECE.		S. L.	S.	W. L.	W. R.	—	+
Braces.	A B	—1,790	—1,160	+1,650	—1,300	4,250	
	B C	" 1,050	" 1,040	" 3,250	" 2,560	4,550	2,200
	C D	" 90	+ 250	" 750	" 1,160	1,250	910
	D E	" 1,050	—1,040	— 500	+1,300	2,550	250
	E A	" 1,790	" 1,160	+5,250	—4,070	7,920	3,460
Rafters.	E G	+3,420	+2,200	" 550	+3,470		9,090
	D H	" 2,800	" 2,200	" 800	" 3,470		8,470
	C I	" 2,800	" 2,200	" 420	" 3,800		8,800
	B K	" 3,420	" 2,200	" 1,450	" 2,600		8,220

When the wind blows from the right, the diagram marked **W. R.** will be drawn. The lines *i h g f*, representing the wind, will correspond in value with *g i k l* of the preceding figure, and, since the other diagram was constructed first, the vertical reaction at L will now be obtained by drawing the horizontal line *a′a*, from either the angle of the parallelogram or the proper point of division of the resultant *i f*, so as to give *a i*, the smaller part of the vertical component of the wind pressure; that is, *l a*, from **W. L.**, plus *a i*, from **W. R**, equals the vertical projection of the polygon of external forces.

When this diagram is completed by the customary rules, a comparison of it with the one just preceding will make clear the effect of wind on different sides. The stress in the rafters is much greater when the wind blows on the side farthest from the rollers, but it is al

ways compressive. The forces in the braces are all reversed.

The weight of the roof and truss may be the only external force, or snow may be added; and, in either case, the wind may also blow on one side or the other. Selecting then from the table those stresses which may exist together, we find the maximum tension and compression in each piece, as given in the last two columns. The rafters are always compressed, and A B is always in tension. The other pieces must be designed to resist both kinds of stress, although the compression on D E is quite insignificant.

REVIEW OF THE WORK OF THE CHICAGO ACADEMY OF SCIENCES.

An Address delivered by President Johnson at the Annual Meeting, January 11th, 1876.

MEMBERS OF THE ACADEMY:

Ladies and Gentlemen.—In transmitting to my successor the trust with which you have twice honored me, I shall only briefly refer to the progress reached in the work of the society.

The additions to the library during the last two years, have been of bound volumes about one hundred, of unbound volumes and pamphlets about five hundred. The additions to the museum have been large and valuable. The collection made by the Florida Expedition, under the ausipces of the Academy, through the liberality of E. W. Blatchford, Esq., consists of several thousand specimens, only a few of which have been mounted or properly displayed. Donations from different individuals and purchase, including the Ward collection of casts of typical fossils in the different Museums of this country and Europe, amount to about thirty-five hundred. A large number of alcoholic preparations have also been received, but which have not been arranged, of which I have no definite information. But, gentlemen, what we want is, not so much material as room for it, and care of it, and such a display of it as will make it useful.

The scientific work of the Academy has not been large. We have had no funds to publish even what we have done, but that we have not been entirely inactive, will be evident from the following enumeration of the titles of papers presented since October, 1873, the date of our first meeting in the present building. Prof. E. Andrews, at that meeting, presented and explained "A New Theory of the Intermitting Action of the Geysers," illustrated with apparatus; Prof. H. H. Babcock announced the "Discovery of a New Plant, *Dalea Alopecuroides*,"—growing wild near Chicago. The plant is not indiginous, hence Prof. Babcock thought it, or its seeds, must have been brought from the Rocky Mountains by the railway trains. Nov. 1, 1873, Dr. R. Dexter read a paper on the "Facial Angle in the Vertebrate Animals." This paper was subsequently published in an Eastern scientific journal. Dr. E. Andrews discussed the "Formation of the Loess and Boulder Drift." January 13th, Judge J. D. Caton read a paper on the "Irregularity of the Flow of Artesian Wells. Prof. Delafontaine read a paper entitled, "Agassiz versus Darwin, —or Creation versus Evolution." Prof. E. Colbert presented a proposition to perform the "Pendulum Experiment" of Foucault, in the Exposition building. October 14th, 1874, Prof. Delafontaine gave a summary of his "Experiments Recently Performed to Demonstrate the Existence of the Metal Terbium as an Element." He also described observations made by Dr. Simon and himself, on the "Spectroscopic Properties of the Blood." Dr. E. Andrews read a paper on the "Mirage of Lake Michigan," The paper was illustrated by charts. Prof. E. Colbert read a paper on the "Moon's Distance." May 12th, 1874, Prof. Colbert read a paper on the "Velocity of Light." Ex-Gov. Bross read a paper on the "Late Destructive Floods of the Mississippi Valley." June 9th, 1874, S. W. Burnham, Esq., read a paper detailing recent observations made by him upon "Double Stars." Oct. 13th, 1874, a "Plan of Old Fort Joe Williams, by Dr. Wm. M. Keys," with remarks by Dr. E. Andrews, was presented. Nov. 10th, 1874, W. W. Calkins, Esq., read a paper on the "Progress of the Study of American Land and Fresh Water Mollusks, with Notes of Species found in Cook County, Illinois." Prof. Delafontaine detailed experiments by himself and Dr. Simon as to the "Physiological Action of Chloral Hydrate." Prof. Colbert read a paper on the "Eclipse of the Moon, October 24th, 1874." Dr. E. Andrews read a paper, illustrated by maps, on the "Fortifications of the Mound Builders in Armada, Michigan." Dec. 9th, 1874, Prof. Colbert read a paper on the "Transit of Venus." W. W. Calkins, Esq., read a paper on the "Developement of Natural History as a Science." Jan. 12th, 1875, E. W. Blatchford, Esq., announced that an expedition would start for the Florida Seas for the purpose of making collections for the Academy. March 9th, 1875, Prof. Colbert presented some statements as to "Planetary Atmospheres." April 13th, 1875, Prof. H. H. Babcock read a paper by Amos Sawyer, of Willsboro, on "How the Forests Have Encroached Upon the Prairies of Illinois." June 15th, 1875, Dr. Velie read at length a "Report of Work Done by the Expedition to the Florida Coast and Seas." Prof. S. W. Peabody read a paper, illustrated by charts, detailing his "Experiments Upon the Flow of Sap in Trees." Prof. Babcock related his "Discovery of the Manner of the Distribution of the Spores of the firm *Aspidium Acrosteacoides*." Dec. 11th, 1875, Hon. J. D. Caton read a paper on the "Habits and Habita of the Reindeer." Ex-Gov. Bross presented a "Report of the Life and Services to Science of the late Prof. I. A. Lapham."

Such, gentlemen, is an outline of the scientific work done by the Academy since we have occupied our present rooms—a little more than two years.

The destruction, in 1871, of our building, with all our collections and deposits, valued at nearly half a million of dollars—the death of our Secretary, Prof. Stimpson—soon afterwards the subsequent death of Col. J. W. Foster, the President of the Academy,—and the financial crisis, through which our community, in common with the whole country, is now passing—have all combined during the past five years to make the friends of the Academy anxious, not for its growth merely, but for its very existence.

The courage and liberality of our Trustees has provided a new building. The confidence of scientific men, and of sister societies, has filled this building with valuable material. Our library is receiving almost constantly new and useful additions. We only need funds to provide for the care and display of what we have, and what we can get to make the museum not only attractive to the casual visitor, but what is of much more importance, of great value to the student of science. For these means the Academy must be dependent upon the liberality and public spirit of the people of our city. Their attention has for a time been almost necessarily diverted from institutions of art, literature and science, and the great value of their agents as means of culture, and as evidence of wealthy social developement. But no great city can afford to neglect, for any length of time, the interests of education. Chicago must not only perform, in a mechanical way, functions as a manufacturing and commercial agent, but something more than this,—art must beautify her work, literature must be acquainted with the best that the world has done, and science must reveal to her the myriad forms of life and modes of motion, and must suggest how facts and forces may be made to minister to human wants,—in a word, must make of our over-grown boy of a town, full of vigorous life and ready to dare and do great deeds,—a strong, cultured, manly city,—a city that shall be inviting as a home for families, that shall be full of all forms of happy suggestions.

We confidently believe, therefore, that this Academy will be sustained, and that our citizens will provide the means to make its collections useful.

The American Screw Company, of Providence, R. I., proposes to establish branch factories in Dundas, Canada, for the purpose of manufacturing screws without paying a duty on the raw material, thus enabling it to compete with British manufacturers. They have purchased an estate in Dundas, in Upper Canada, at the western end of Lake Ontario, on which there is a factory for the manufacture of screws, and where they contemplate erecting a building one hundred and fifty by fifty feet, with a capacity of ten thousand gross screws daily, and employing some five hundred hands. Other branch factories will probably be established at Montreal, Toronto, Quebec and elsewhere in the Dominion. Ground for the new building at Dundas will be broken in the course of two weeks.

The remarks of Dr. Andrews at the Academy of Sciences will be given next week.

ACADEMY OF SCIENCES.

February Meeting, 1876.

The regular monthly meeting of the Academy of Sciences was held at the rooms of the society, No. 263 Wabash Avenue, on Tuesday evening, February 8th. President Blatchford in the chair, with a large attendance of members and visitors.

The minutes of the last meeting were read and approved. The following is the list of donations to the library and museum received since the last meeting:

From the Engineer's Department U. S. A. Parts 1 and 2, Reports for 1875; from Department of the Interior. Bulletin No. 4; from Buffalo Society of Nat. History. Bulletins No. 2, Vol. 3, 1876; from Peabody Academy of Sciences. 1 copy memoirs No. 4, Vol. 1 1876; from Dresdon. 1 pamphlet; from Dr. H. A. Johnson. 4 volumes 4to, of Contributions to Knowledge by Louis Agassiz, full bound.

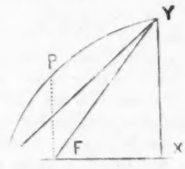
The donations to the museum of the Academy since the last meeting, have been:

From Miss. Smith. 4 nests; from E. W. Nelson. 1 specimen of Flounder; from Frank L. DeWitt. 1 skin of Herring Gull; from Mr. A. Vatter, Monroe, Ill. 1 Short-eared Owl; from J. W. Viele. 1 Turkey, 1 Dashy Duck, 1 Rail, *Rolus Elegans*.

The President called the attention of the Academy to the very valuable donation of Dr. H. A Johnson, Past President, to the library.

QUADRATURE OF CONIC SECTIONS.

Mr. E. Colbert presented the partial development of a new formula, which he hoped to lay more fully before the Academy at a future meeting. His object was to show how to obtain the area of any part of any conic section, from one formula—simple enough to be easily handled. Meanwhile he offered the following, as giving the required area nearly enough for ordinary purposes. Its simplicity especially recommends it in cases where the eccentricity is nearly equal to unity, or where x is nearly equal to a. Those cases have hitherto been the most troublesome to deal with, and exceedingly formidable in astronomical investigations.



The semi-axis major $= a$; it is negative in the hyperbola, and infinite in the parabola.

F is the focus; A the vertex. A F $= m$.

The eccentricity $= e$;

$$= \frac{a \mp m}{a}. \quad P F = p; = m(1+e); = a(1-e^2)$$

For any point Y in the curve, A X $= x$; and

$$Y X = y, = \sqrt{p x \left\{2 \mp \frac{x}{a}\right\}}$$

The radius vector F Y $= r; = m(1+e x)$.

For the area; take

$$u = 2{\cdot}4 \pm \frac{0{\cdot}23x}{3{\cdot}393a \mp x}: \qquad \text{Then,}$$

$$\text{The Area A Y P A} = \frac{x y}{6 \mp \frac{4x}{a}}; \; = y \frac{x}{6 \mp \frac{4x}{a}}$$

$$\text{The Area A X Y A, (triangle)} = y\frac{x}{2}$$

$$\text{The Area A F Y A, (triangle)} = y\frac{m}{2}$$

$$\text{The Rectangular Area A X Y P A} = y\left\{\frac{x}{6 \mp \frac{4x}{a}} + \frac{x}{2}\right\}$$

$$\text{The Polar Area A F Y P A} = y\left\{\frac{x}{6 \mp \frac{4x}{a}} + \frac{m}{2}\right\}$$

The quantities following the double sign vanish in the parabola. The upper sign applies to the circle and ellipse; the lower sign applies to the hyperbola.

For values of x less than eight-tenths of a the resulting ratio is true at least to the fifth place of decimals; and it is true to the sixth place if x be not greater than about one-half of a.

In the circle or ellipse, when x equals a, this formula gives the ratio of the area to xy too small by one unit in the sixth decimal place.

In the case of orbits which approach nearly to the parabolic form, the formula may be regarded as giving the area correctly, within the limits of observation. It is near enough to the truth for all practical purposes in the

case of any hyperbolic orbit having the sun in one focus, for any value of x that can be observed.

It does not hold good for values of x much greater than a.

A letter from Dr. N. S. Davis Jr., of Evanston, Ill., to Dr. E. Andrews of this city, giving an account of the

"VEGETABLE AND ANIMAL SUBSTANCES THROWN UPON THE SHORE OF LAKE MICHIGAN AT EVANSTON DURING A STORM"

was read by Prof. Babcock, the well known botanist of this city, who made some very interesting remarks upon the Algæ of Lake Michigan. He remarked that those described by Dr. Davis were the same as were dredged from a depth of 430 feet, near Racine, Wisconsin, last summer.

In answer to Mr. Bross, Prof. Babcock stated that vegetation had been found at the lowest depths of lake Michigan yet dredged.

EVANSTON, Feb. 4, 1876

On the night of Jan. 1st, the wind reached the velocity of 44 miles an hour, blowing, if I remember rightly, from the south and a little from the west. Jan. 2 and 3 it continued to blow from the west, but Jan. 4 it turned around and came from the east at the rate of 12 miles an hour. Jan. 5 it again came up from the southwest; on this day Mr. Rice and myself made our collections. After the storm of the night of the first of Jan. the shore was strewn with algæ, crawfishes and here and there mudpuppies and shells.

By the side of one short breakwater we found the algæ piled up in great quantities; it was about a foot and a half deep over a space of 30 or 40 square feet. We find this only after a *heavy* storm, generally one from the east. I have always supposed that it grew in quite deep water. Prof. Marcy wrote to Prof. Asa Gray, in 1871, asking him to determine it, and also saying that he thought it grew in deep water as it was only found after a heavy storm, and was not known to grow close to shore. Prof. Gray answered him, giving the name as *Nostoc spherecoides* of *Kutzing*, and added "Pray keep a lookout for it from year to year. It ought not to grow in very deep water."

This plant is a rather fine, spherical mass; varying from the size of a small shot to that of a good sized cherry. Some specimens are smooth, others rough or warty. When examined under a microscope it seems filled with chains of spherical cells; these are the filaments and produce the spores. The chains are much more numerous near the surface. The specimens that I have examined present the following characters:—Varying in color from dark brown to light green. The general shape is smooth and orbicular, oval or irregular, being warty or noduled. The cells of the filaments are sub-quadrate, The filaments vary in color from green to yellow. The centre of large specimens is hollow.

We found great quantities of craw-fishes, mostly rather small ones. Also quite a numbe of small fishes and a few of medium size. Among the larger ones I observed the common perch, *Perca flavescens*, Cuv., the lake herring, *Argyrosomus clupeiformis*, (M. N.) Ag., the bull head, *Amiunrus*, and the white-fish, *Coregonus albus*, Lesm. Mr. Rice collected a number of different species of the smaller fishes, but by accident they were destroyed and I am not able to give a list of them.

There was washed up on the pile of algæ that I first mentioned as many as ten mudpuppies, *Necturus lateralis*, Say. Quite a number of others were also found on other parts of the shore. We obtained only two that were alive, Some time ago, Mr Rice had one brought to him which was frozen tightly into the ice. It was taken into the house and left for a short time near the stove. On examining it a second time he found that it showed signs of life. After leaving it again for some time in a pan of water near the fire, it came entirely out of its lethargic state and is now doing finely.

In the same place we found six frogs, *Rana halecina*, Kalm. sub-species *berlandieri*, several of these were alive but rather stupid, and all were exceedingly thin. Mr. Cutler writes that on the 31 of Dec., at Rosecrans, Lake Co., Ill. he saw a great many frogs in a pond. They were croaking and making a great noise. The next day they had all disappeard.

Washing against the same pile of algæ, we discovered two specimens of *Arvicola riparia*, Ord., the meadow mouse, and one *Hesperomys leucopus*, (Ray.) Leconte, the white-footed or deer mouse.

Among the mollusca were *Melaniæ* (alive), *Physa heterostropha*, Say., *Helix alternata*, Say., *Sphæricum rhomboideum*, Say. (alive), and *Anodontæ*, (alive). In one place we found the shells qnite abundant. *Helix alternata* I have never found on our sand-ridges, but about six miles north in the clay bank I have seen great quantities of them.

A few days since I received a letter from Dr. Hoy of Racine who says that the algæ was thrown up there just as it was here, and also added that he had received a letter from Charles Mann of Milwaukee, in which he said he had found in that place immense quantities of algæ and craw-fish, frogs, trout, lawyers, and a number of small "*Cotur*," two of which he sent to Dr. Hoy, who thinks they "will prove a new species."

I have given here the facts in regard to the last storm so far as I observed them.

NATHAN L. DAVIS, JR.

The meeting then adjourned to the upper hall of the museum where Dr. E. Andrews, Past President, illustrated some remarks on the Megatherium by means of some excellent specimens from the collection of the "Ward casts" lately obtained by the Academy.

The meeting then adjourned.

Proposals for Contracts.

ROOFING AND CORNICE WORK AND ORNAMENTATION.—Notice is hereby given that the State House Commissioners will receive proposals to furnish in place, complete, the metallic cornices, caps, and covering of the upper dome, including the lantern, and the ornamentation of the mansard roof, turrets, and dome. Separate bids will be received, first for the roofing and cornice work, second, for the ornamentation. The plans and specifications for said work may be seen, and printed specifications will be furnished, on application at the office of A. H. Piquenard, Acting Architect, in the new State House, on and after the 21st day of February, 1876. Proposals will be open at 12 o'clock noon, March 4th 1876, at Springfield. A. H. Piquenard, *Acting Arch.*

Jacob Bunn, John T. Stuart Jas. H. Beveridge, *Commissioners.*

Springfield, Ill. Feb. 2, 1876.

CONVICT LABOR TO LET.—Sealed proposals will be received by the undersigned up to 1 o'clock p. m. February 26th 1876, for the labor of from 100 to 250 convicts. For further particulars address the undersigned, or R. W. McClaughry, *Warden of the prison.* Woodbury M. Taylor, John M. Southworth, Robert D. Noleman, *Commissioners Illinois State Penitentiary.*

Joliet, January 21, 1876.

PROPOSALS FOR SEWER PIPE.—Proposals will be received at Sewer Department, City Hall, Boston, till March 1 for the whole or any part of 20,000 feet of 12-inch vitrified sewer pipe, including 1,000 6-inch branches. Apply as above for specification and form of proposal. Clinton Viles, *Chairman Committee on Sewers.*

PROPOSALS FOR IRON.—Sealed proposals are invited to furnish, delivered at this Arsenal, the following: 30,000 lbs. of 12-inch wrought iron I beams. 85,000 lbs. of 7-inch wrought iron deck beams. 105,000 lbs. of 4-inch wrought iron I beams. 20,000 lbs of T iron from 2½ in. x 3½ in. to 2½ in. x 5½ in. 56,000 lbs. of round bar iron from ⅜ in. to 2¼ in. diameter. 38,000 lbs. of flat and square bar iron, various. Proposals will be opened at 10 a. m. March 10, 1876. For full bill of iron, specifications for quality, and other information, apply to the undersigned. D. W. Flagler, *Major of Ordinance.*

Rock Island Arsenal, Ill. Jan. 29, 1876.

ELECTRICIAN WORK.—Proposals for the electrician work for the new Capitol, at Lansing, Michigan, including all the necessary apparatus for the lighting of the gas, also for operating the call bells, annunciators, etc.—either separately or in connection with the gas lighting—will be received by the Board of State Building Commissioners until 12 o'clock noon on Tuesday, March 7. 1876, and will be opened at the office of E. E. Myers, architect, Detroit, at 8 o'clock p. m. of same day. John J. Bagley, *Governor.* E. F. Grosvenor, James Shearer, Alex Chapoton, *State Building Commissioners.* Allen L. Bours, *Secretary.*

Lansing, Mich., February 4, 1876.

In 1865, the well-known correspondent of the *London Times*, W. H. Russell, uttered a prophecy which time has since fulfilled almost to the letter. He then wrote:—"As a mite would in all probability never have been seen but for the invention of cheese, so it may be that there is some undeveloped creation waiting *perdu* for the first piece of gutta-percha which comes down—to the sea-bottom—to arouse his faculty and fulfill his functions of life—a gutta-percha boring and eating *teredo*, who has been waiting for his meal since the beginning of the world."

This enemy of submarine cables has already made his appearance, as was briefly announced in a recent number of the *Popular Science Monthly*. It is a crustacean, less than a quarter of an inch in length, and known as *Limnoria terebrans*. "One breakfast which he may take," says Dr. J. H. Gladstone, "may cost more than the breakfast of any luxurous Roman epicure in ancient times, because he may destroy a whole cable, and it may take a year to repair the damage which he may do in a minute."

SELECTED LIST OF PATENTS

For the week ending February 4th, 1876.

Relating to Mining, Metallurgy, Engineering, &c., reported for ENGINEERING NEWS by Louis Bagger & Co., Solicitors of Patents, Washington, D. C.

173,302. Furnace for Tempering Glass. F. B. A. Royer de la Bastie, Paris, France.

The vat is covered by a table, adapted, when its contents are raked to the side, to be tilted off, to permit of the immersion of the articles on an endless belt. These are thus conveyed to a wire cloth basket, by which they are taken from out the liquid.

172,629. Ore Furnaces. H. G. Livermore, San Francisco, Cal.

The Ore Chamber is contracted just above the exit passage from the furnaces, so that full five exposures is secured without clogging the passages. The escape flues discharge into a chamber encompassing the ore chimney, which, by reason of its situation, heats the descending ore.

172,386. Ventilated Sewer Traps. James T. Campbell, New York, N. Y.

A trap box is placed either inside or directly outside of, the building to which it is applied, and an air pipe is arranged to pass up through the building to some place above the roof, whence the foul gases that escape through the trap may be discharged into the open air.

172,443. Machine for Welding the Ends of Tubes. Albert L. Ide, Springfield, Ill.

The tube is griped with yielding pressure by a pair of automatically-operating jaws upon the forward movement of the carriage, the said jaws opening to release the same when the carriage is retracted. The open, heated end of the tube is inserted in a revolving die formed with spiral ribs or corrugation, which compress and draw it inward. The die is also formed with an axial opening, which furnishes a vent for all cinders, scale and surplus metal.

172,461. Chilled Car Wheels. Wm. W. Lobdell, Wilmington, Del.

This is a cast iron car wheel having a chilled rim from which the latent defects beneath the skin have been removed.

172,474. Manufacture of Gas. G. Olney, Brooklyn, N. Y.

Simultaneously mixes steam, liquid or liquifiable carbonaceous matter, and coal gas, previous to the entrance of the mixture into a heated retort, by a steam-jet, steam liquid, or liquifiable carbonaceous matter, and coal gas.

HELLER & BRIGHTLY, Engineering and Surveying Instruments, 33 N. Seventh St., Philadelphia.

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Extract from report of Committee of Civ. Engs. appointed by Franklin Inst. to examine H. & B.'s new Transit (Dec. 1871): "It exhibits several novelties of construction which, in the opinion of the committee, render it superior to those now in use, and in its opinion the deviations which they have made from the common styles of Transit are decided improvements."

JOHN C. TRAUTWINE, Chairman.

REG. JUNE 8TH 1871.

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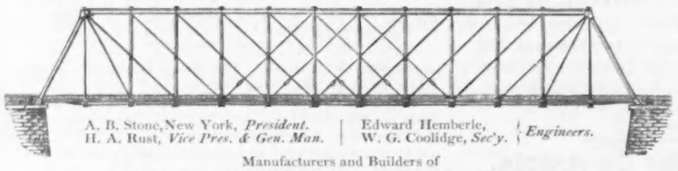

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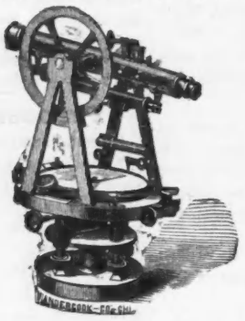

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